Claims

1. A mass spectrometer comprising:

an ion beam attenuator for transmitting and attenuating a beam of ions, wherein, in use, said ion beam attenuator is repeatedly switched between a first mode of operation wherein the ion transmission is substantially 0% and a second mode of operation wherein the ion transmission is > 0%.

2. A mass spectrometer as claimed in claim 1, wherein said ion beam attenuator has an average or overall transmission of x%, wherein x is selected from the group consisting of: (i) < 0.01; (ii) 0.01-0.05; (iii) 0.05-0.1; (v) 0.1-0.5; (vi) 0.5-1.0; (vii) 1-5; (viii) 5-10; (ix) 10-15; (x) 15-20; (xi) 20-25; (xii) 25-30; (xiii) 30-35; (xiv) 35-40; (xv) 40-45; (xvi) 45-50; (xvii) 50-55; (xviii) 55-60; (xix) 60-65; (xx) 65-70; (xxi) 70-75; (xxii) 75-80; (xxiii) 80-85; (xxiv) 85-90; (xxv) 90-95; and (xxvi) > 95.

3. A mass spectrometer as claimed in claim 1 or 2, wherein said ion beam attenuator is switched between said first mode of operation and said second mode of operation with a frequency of: (i) < 1 Hz; (ii) 1-10 Hz; (iii) 10-50 Hz; (iv) 50-100 Hz; (v) 100-200 Hz; (vi) 200-300 Hz; (vii) 300-400 Hz; (viii) 400-500 Hz; (ix) 500-600 Hz; (x) 600-700 Hz; (xi) 700-800 Hz; (xii) 800-900 Hz; (xiii) 900-1000 Hz; (xiv) 1-2 kHz; (xv) 2-3 kHz; (xvi) 3-4 kHz; (xvii) 4-5 kHz; (xviii) 5-6 kHz; (xix) 6-7 kHz; (xx) 7-8 kHz; (xxi) 8-9 kHz; (xxii) 9-10 kHz; (xxiii) 10-15 kHz; (xxiv) 15-20 kHz; (xxv) 20-25 kHz; (xxvi) 25-30 kHz; (xxvii) 30-35 kHz; (xxviii) 35-40 kHz; (xxix) 40-45 kHz; (xxx) 45-50 kHz; and (xxxi) > 50 kHz.

4. A mass spectrometer as claimed in claim 1, 2 or 3, wherein said ion beam attenuator is operated in said first mode of operation for a time period ΔT_1 and is then operated in said second mode of operation for a time period ΔT_2.

5. A mass spectrometer as claimed in claim 4, wherein $\Delta T_1 > \Delta T_2$.

6. A mass spectrometer as claimed in claim 4, wherein $\Delta T_1 \leq \Delta T_2$.

7. A mass spectrometer as claimed in claim 4, 5 or 6, wherein said time period ΔT_1 is selected from the group consisting of: (i) < 0.1 μs; (ii) 0.1-0.5 μs; (iii) 0.5-1 μs; (iv) 1-50 μs; (v) 50-100 μs; (vi) 100-150 μs; (vii) 150-200 μs; (viii) 200-250 μs; (ix) 250-300 μs; (x) 300-350 μs; (xi) 350-400 μs; (xii) 400-450 μs; (xiii) 450-500 μs; (xiv) 500-550 μs; (xv) 550-600; (xvi) 600-650 μs; (xvii) 650-700 μs; (xviii) 700-750 μs; (xix) 750-800 μs; (xx) 800-850 μs; (xxi) 850-900 μs; (xxii) 900-950 μs; (xxiii) 950-1000 μs; (xxiv) 1-10 ms; (xxv) 10-50 ms; (xxvi) 50-100 ms; (xxvii) > 100 ms.

8. A mass spectrometer as claimed in any of claims 4-7, wherein said time period ΔT_2 is selected from the group consisting of: (i) < 0.1 μs; (ii) 0.1-0.5 μs; (iii) 0.5-1 μs; (iv) 1-50 μs; (v) 50-100 μs; (vi) 100-150 μs; (vii) 150-200 μs; (viii) 200-250 μs; (ix) 250-300 μs; (x) 300-350 μs; (xi) 350-400 μs; (xii) 400-450 μs; (xiii) 450-500 μs; (xiv) 500-550 μs; (xv) 550-600; (xvi) 600-650 μs; (xvii) 650-700 μs; (xviii) 700-750 μs; (xix) 750-800 μs; (xx) 800-850 μs; (xxi) 850-900 μs; (xxii) 900-950 μs; (xxiii) 950-1000 μs; (xxiv) 1-10 ms; (xxv) 10-50 ms; (xxvi) 50-100 ms; (xxvii) > 100 ms.

9. A mass spectrometer as claimed in any of claims 4-8, further comprising a control device wherein, in use, said control device adjusts either the time period ΔT_1 and/or the time period ΔT_2 in order to adjust or vary the transmission or attenuation of said ion beam attenuator.

10. A mass spectrometer as claimed in any of claims 4-9, wherein, in use, the mark space ratio $\Delta T_2/\Delta T_1$ is adjusted in

order to adjust or vary the transmission or attenuation of said ion beam attenuator.

11. A mass spectrometer as claimed in any preceding claim, further comprising an ion detector wherein in either said first mode of operation and/or said second mode of operation at least a portion of the beam of ions is substantially directed towards said ion detector and wherein said ion detector measures the ion current of said beam of ions.

12. A mass spectrometer as claimed in any of claims 4-11, wherein a control device adjusts or varies either the time period ΔT_1 and/or the time period ΔT_2 based upon an ion current as measured by an ion detector.

13. A mass spectrometer as claimed in any of claims 4-12, wherein in the event that one or more mass peaks in one or more mass spectra are determined as suffering from saturation effects or are determined as approaching saturation then either the time period ΔT_1 and/or the time period ΔT_2 is adjusted or varied.

14. A mass spectrometer as claimed in any of claims 4-13, wherein in the event that mass data or mass spectral data are determined as suffering from saturation effects or are determined as approaching saturation then either the time period ΔT_1 and/or the time period ΔT_2 is adjusted or varied.

15. A mass spectrometer as claimed in any of claims 4-14, wherein in the event of an ion current being determined to exceed a certain level or threshold then either the time period ΔT_1 and/or the time period ΔT_2 is adjusted or varied.

16. A mass spectrometer as claimed in any preceding claim, wherein said ion beam attenuator comprises one or more electrostatic lenses.

17. A mass spectrometer as claimed in claim 16, wherein said one or more electrostatic lenses comprise one or more electrodes and wherein one or more first voltages are applied to said one or more electrodes in said first mode of operation and wherein one or more second different voltages are applied to said one or more electrodes in said second mode of operation.

18. A mass spectrometer as claimed in claim 17, wherein said one or more first voltages fall within a range selected from the group consisting of: (i) ± 0-10 V; (ii) ± 10-20 V; (iii) ± 20-30 V; (iv) ± 30-40 V; (v) ± 40-50 V; (vi) ± 50-60 V; (vii) ± 60-70 V; (viii) ± 70-80 V; (ix) ± 80-90 V; (x) ± 90-100 V; (xi) ± 100-200 V; (xii) ± 200-300 V; (xiii) ± 300-400 V; (xiv) ± 400-500 V; (xv) ± 500-600 V; (xvi) ± 600-700 V; (xvii) ± 700-800 V; (xviii) ± 800-900 V; (xix) ± 900-1000 V; (xx) > 1000 V; and (xxi) < -1000 V.

19. A mass spectrometer as claimed in claim 17 or 18, wherein said one or more second voltages fall within a range selected from the group consisting of: (i) ± 0-10 V; (ii) ± 10-20 V; (iii) ± 20-30 V; (iv) ± 30-40 V; (v) ± 40-50 V; (vi) ± 50-60 V; (vii) ± 60-70 V; (viii) ± 70-80 V; (ix) ± 80-90 V; (x) ± 90-100 V; (xi) ± 100-200 V; (xii) ± 200-300 V; (xiii) ± 300-400 V; (xiv) ± 400-500 V; (xv) ± 500-600 V; (xvi) ± 600-700 V; (xvii) ± 700-800 V; (xviii) ± 800-900 V; (xix) ± 900-1000 V; (xx) > 1000 V; and (xxi) < -1000 V.

20. A mass spectrometer as claimed in any preceding claims, wherein in said first mode of operation a voltage is applied to one or more electrodes of said ion beam attenuator, wherein said voltage causes an electric field to be generated which acts to retard and/or deflect and/or reflect and/or divert said beam of ions.

21. A mass spectrometer as claimed in any of claims 16-20, wherein said one or more electrostatic lenses comprise at

least first, second and third electrodes or first, second and third pairs of electrodes.

22. A mass spectrometer as claimed in claim 21, wherein in said first mode of operation a voltage is applied to either said first and/or said second and/or said third electrodes or to said first and/or said second and/or said third pair of electrodes of said ion beam attenuator, wherein said voltage causes an electric field to be generated which acts to retard and/or deflect and/or reflect and/or divert said beam of ions.

23. A mass spectrometer as claimed in any preceding claim, wherein said ion beam attenuator further comprises a differential pumping exit electrode or plate.

24. A mass spectrometer as claimed in claim 23, wherein said differential pumping exit electrode or plate has an aperture having an area selected from the group consisting of: (i) < 1 mm^2; (ii) 1-2 mm^2; (iii) 2-3 mm^2; (iv) 3-4 mm^2; (v) 4-5 mm^2; (vi) 5-6 mm^2; (vii) 6-7 mm^2; (viii) 7—8 mm^2; (ix) 8-9 mm^2; (x) 9-10 mm^2; and (xi) > 10 mm^2.

25. A mass spectrometer as claimed in any preceding claim, wherein in said first mode of operation said beam of ions is retarded and/or reflected and/or deflected and/or diverted.

26. A mass spectrometer as claimed in any preceding claim, wherein in said second mode of operation said beam of ions is substantially unretarded and/or not reflected and/or undeflected and/or undiverted.

27. A mass spectrometer as claimed in any preceding claim, wherein said ion beam attenuator comprises a mechanical shutter or mechanical ion beam attenuator.

28. A mass spectrometer as claimed in any preceding claim, wherein said ion beam attenuator comprises a magnetic ion gate or magnetic ion beam attenuator.

29. A mass spectrometer as claimed in any preceding claim, further comprising one or more mass filters arranged upstream and/or downstream of said ion beam attenuator.

30. A mass spectrometer as claimed in any preceding claim, further comprising one or more ion guides or one or more gas collision cells arranged upstream and/or downstream of said ion beam attenuator.

31. A mass spectrometer as claimed in claim 30, wherein said one or more ion guides or gas collision cells are maintained, in use, at a pressure selected from the group consisting of: (i) < 0.001 mbar; (ii) 0.001-0.005 mbar; (iii) 0.005-0.01 mbar; (iv) 0.01-0.05 mbar; (v) 0.05-0.1 mbar; (vi) 0.1-0.5 mbar; (vii) 0.5-1 mbar; and (viii) > 1 mbar.

32. A mass spectrometer as claimed in claim 30 or 31, wherein said one or more ion guides or gas collision cells act to convert a pulsed or non-continuous ion beam into a substantially continuous, pseudo-continuous or near continuous ion beam.

33. A mass spectrometer as claimed in claim 30, 31 or 32, wherein, in use, one or more axial DC potential gradients are maintained along at least 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% of said one or more ion guides or gas collision cells.

34. A mass spectrometer as claimed in any of claims 30-33, wherein, in use, one or more time varying DC potentials or DC potential waveforms are applied to at least a portion of said one or more ion guides or gas collision cells so that at least some ions are urged along said one or more ion guides or gas collision cells.

35. A mass spectrometer as claimed in any of claims 30-34, wherein, in use, one or more axial trapping regions are provided within said one or more ion guides or gas collision cells and wherein said one or more axial trapping regions are translated along at least a portion of said one or more ion guides or gas collision cells.

36. A mass spectrometer as claimed in any of claims 30-35, wherein said one or more ion guides or gas collision cells are selected from the group consisting of: (i) an RF or AC multipole rod set ion guide or gas collision cell; (ii) a segmented RF or AC multipole rod set ion guide or gas collision cell; (iii) an RF or AC ion tunnel ion guide or gas collision cell comprising a plurality of electrodes having apertures through which ions are transmitted in use and wherein at least 50% of said electrodes have substantially similar sized apertures; and (iv) an RF or AC ion funnel ion guide or gas collision cell comprising a plurality of electrodes having apertures through which ions are transmitted in use and wherein at least 50% of said electrodes have apertures which become progressively larger or smaller.

37. A mass spectrometer as claimed in any preceding claim, further comprising a mass analyser.

38. A mass spectrometer as claimed in claim 37, wherein said mass analyser is selected from the group consisting of: (i) an orthogonal acceleration Time of Flight mass analyser; (ii) an axial acceleration Time of Flight mass analyser; (iii) a Paul 3D quadrupole ion trap mass analyser; (iv) a 2D or linear quadrupole ion trap mass analyser; (v) a Fourier Transform Ion Cyclotron Resonance mass analyser; (vi) a magnetic sector mass analyser; (vii) a quadrupole mass analyser; and (viii) a Penning trap mass analyser.

39. A mass spectrometer as claimed in claim 37 or 38, wherein said mass analyser mass analyses or acquires, histograms, accumulates, records or outputs mass spectra, mass spectral data or mass data in use, with a frequency f_1 and wherein said ion beam attenuator switches, in use, from said first mode of operation to said second mode of operation with a frequency f_2.

40. A mass spectrometer as claimed in claim 39, wherein said frequency f_2 is asynchronous to said frequency f_1.

41. A mass spectrometer as claimed in claim 39 or 40, wherein $f_2 > f_1$.

42. A mass spectrometer as claimed in claim 41, wherein the ratio f_2/f_1 is at least: (i) 2; (ii) 3; (iv) 4; (v) 5; (vi) 6; (vii) 7; (viii) 8; (ix) 9; (x) 10; (xi) 15; (xii) 20; (xiii) 25; (xiv) 30; (xv) 35; (xvi) 40; (xvii) 45; (xviii) 50; (xix) 55; (xx) 60; (xxi) 65; (xxii) 70; (xxiii) 75; (xxiv) 80; (xxv) 85; (xxvi) 90; (xxvii) 95; (xxviii) 100; (xxix) 110; (xxx) 120; (xxxi) 130; (xxxii) 140; (xxxiv) 150; (xxxv) 160; (xxxvi) 170; (xxxvii) 180; (xxxviii) 190; (xxxix) 200; (xxxx) 250; (xxxxi) 300; (xxxxii) 350; (xxxxiii) 400; (xxxxiv) 450; and (xxxxv) 500.

43. A mass spectrometer as claimed in claim 39 or 40, wherein $f_2 \leq f_1$.

44. A mass spectrometer as claimed in any preceding claim, further comprising an ion source selected from the group consisting of: (i) an Electrospray ionisation ("ESI") ion source; (ii) an Atmospheric Pressure Photo Ionisation ("APPI") ion source; (iii) an Atmospheric Pressure Chemical Ionisation ("APCI") ion source; (iv) a Matrix Assisted Laser Desorption Ionisation ("MALDI") ion source; (v) a Laser Desorption Ionisation ("LDI") ion source; (vi) an Atmospheric Pressure Ionisation ("API") ion source; (vii) a Desorption Ionisation on Silicon ("DIOS") ion source; (viii) an Electron

Impact ("EI") ion source; (ix) a Chemical Ionisation ("CI") ion source; (x) a Field Ionisation ("FI") ion source; (xi) a Field Desorption ("FD") ion source; (xii) an Inductively Coupled Plasma ("ICP") ion source; (xiii) a Fast Atom Bombardment ("FAB") ion source; (xiv) a Liquid Secondary Ion Mass Spectrometry ("LSIMS") ion source; (xv) a Desorption Electrospray Ionisation ("DESI") ion source; and (xvi) a Nickel-63 radioactive ion source.

45. A mass spectrometer comprising:

an ion beam attenuator, wherein in use said ion beam attenuator attenuates an ion beam passing through said ion beam attenuator, wherein during one cycle said ion beam attenuator: (a) substantially attenuates said ion beam for a time period ΔT_1 during which time the transmission of ions exiting the ion beam attenuator is substantially 0%; and then (b) substantially transmits said ion beam for a time period ΔT_2 so that ions exit the ion beam attenuator.

46. A mass spectrometer as claimed in claim 45, further comprising a control device for adjusting the mark space ratio $\Delta T_2/\Delta T_1$ in order to adjust or vary the degree of attenuation or transmission of said ion beam attenuator.

47. A mass spectrometer comprising:

an ion beam attenuator for attenuating a beam of ions, wherein, in use, said ion beam attenuator is repeatedly switched between a first mode of operation and a second mode of operation; and

a mass analyser arranged to receive an attenuated beam of ions from said ion beam attenuator, wherein in use said mass analyser mass analyses or acquires, histograms, accumulates, records or outputs mass spectra, mass spectral data or mass data in an asynchronous manner to the switching between modes of said ion beam attenuator.

48. A mass spectrometer comprising:

an ion beam attenuator for attenuating a beam of ions, wherein, in use, said ion beam attenuator is repeatedly switched between a first mode of operation and a second mode of operation at a first frequency; and

a mass analyser arranged to receive an attenuated beam of ions from said ion beam attenuator, wherein in use said mass analyser mass analyses or acquires, histograms, accumulates, records or outputs mass spectra, mass spectral data or mass data with or at a second frequency, wherein said first frequency is greater than said second frequency.

49. A mass spectrometer as claimed in claim 48, wherein said first frequency is at least 10, 20, 30, 40, 50, 60, 70, 80, 90 or 100 times greater than said second frequency.

50. A mass spectrometer comprising:

an ion beam attenuator;

an ion guide or gas collision cell arranged downstream of said ion beam attenuator, said ion guide or gas collision cell being arranged to convert a non-continuous beam of ions into a substantially continuous beam of ions; and

a mass analyser arranged downstream of said ion guide or gas collision cell;

wherein, in use, said ion beam attenuator is switched between a first mode of operation and a second mode of operation at least 10, 20, 30, 40, 50, 60, 70, 80, 90 or 100 times faster than said mass analyser mass analyses or acquires, histograms, accumulates, records or outputs mass spectra, mass spectral data or mass data.

51. A mass spectrometer comprising:

an ion beam attenuator for attenuating an ion beam by an attenuation factor wherein, in use, said ion beam attenuator is repeatedly switched ON and OFF and wherein when said ion beam attenuator is switched ON ions are attenuated substantially 100%; and

a control device for altering or varying the ratio of the time that said ion beam attenuator is ON to the time that

said ion beam attenuator is OFF in order to vary said attenuation factor.

52. A mass spectrometer comprising:

a device for repeatedly (a) chopping, blocking or 100% deflecting or retarding an ion beam and then (b) transmitting said ion beam, wherein said device is arranged to attenuate said ion beam.

53. A mass spectrometer comprising:

a device for attenuating an ion beam wherein the degree of attenuation of said ion beam is determined by setting a mark space ratio of said device.

54. A mass spectrometer comprising;

an ion beam attenuator wherein said ion beam attenuator releases, in use, packets or pulses of ions; and

an ion guide or gas collision cell arranged downstream of said ion beam attenuator, wherein said ion guide or gas collision cell substantially converts or smoothes said packets or pulses of ions into a continuous or pseudo-continuous ion beam.

55. A mass spectrometer as claimed in claim 54, further comprising:

means for repeatedly switching said ion beam attenuator ON and OFF; and

means for varying the mark space ratio of a switching cycle, wherein the mark space ratio is the ratio of the time period during which an ion beam is attenuated to the time period during which an ion beam is transmitted.

56. A method of mass spectrometry comprising:

repeatedly switching an ion beam attenuator between a first mode of operation wherein the ion transmission is substantially 0% and a second mode of operation wherein the ion transmission is > 0%.

57. A method of mass spectrometry comprising:

attenuating an ion beam passing through an ion beam attenuator, wherein during one cycle said ion beam attenuator: (a) substantially attenuates said ion beam for a time period ΔT_1 during which time the transmission of ions exiting the ion beam attenuator is substantially 0%; and then (b) substantially transmits said ion beam for a time period ΔT_2 so that ions exit the ion beam attenuator.

58. A method of mass spectrometry comprising:

attenuating a beam of ions by repeatedly switching an ion beam attenuator between a first mode of operation and a second mode of operation; and

mass analysing or acquiring, histogramming, accumulating, recording or outputting mass spectra, mass spectral data or mass data in an asynchronous manner to the switching between modes of said ion beam attenuator.

59. A method of mass spectrometry comprising:

attenuating a beam of ions by repeatedly switching an ion beam attenuator between a first mode of operation and a second mode of operation at a first frequency; and

mass analysing or acquiring, histograming, accumulating, recording or outputting mass spectra, mass spectral data or mass data at or with a second frequency, wherein said first frequency is greater than said second frequency.

60. A method of mass spectrometry comprising:

providing an ion beam attenuator;

providing an ion guide or gas collision cell downstream of said ion beam attenuator to convert a non-continuous beam of ions into a substantially continuous beam of ions;

providing a mass analyser arranged downstream of said ion guide or gas collision cell; and

switching said ion beam attenuator between a first mode of operation and a second mode of operation at least 10, 20, 30, 40, 50, 60, 70, 80, 90 or 100 times faster than said mass analyser mass analyses or acquires, histograms, accumulates,

records or outputs mass spectra, mass spectral data or mass data.

61. A method of mass spectrometry comprising:

attenuating an ion beam by an attenuation factor by repeatedly switching an ion beam attenuator ON and OFF and wherein when said ion beam attenuator is switched ON ions are attenuated substantially 100%; and

altering or varying the ratio of the time that said ion beam attenuator is ON to the time that said ion beam attenuator is OFF in order to vary said attenuation factor.

62. A method of mass spectrometry comprising:

repeatedly (a) chopping, blocking or 100% deflecting or retarding an ion beam and then (b) transmitting said ion beam in order to attenuate said ion beam.

63. A method of mass spectrometry comprising:

attenuating an ion beam wherein the degree of attenuation of said ion beam is determined by setting a mark space ratio of a device.

64. A method of mass spectrometry comprising;

providing an ion beam attenuator which releases packets or pulses of ions; and

providing an ion guide or gas collision cell downstream of said ion beam attenuator which substantially converts or smoothes said packets or pulses of ions into a continuous or pseudo-continuous ion beam.

65. A mass spectrometer comprising:

an ion beam attenuator for transmitting and attenuating a beam of ions; and

switching means for switching between an attenuation mode of operation wherein an ion beam is attenuated and a non-attenuation mode of operation wherein an ion beam is substantially unattenuated, wherein in said attenuation mode of operation said ion beam attenuator is repeatedly switched

between a first mode of operation wherein the ion transmission is substantially 0% and a second mode of operation wherein the ion transmission is > 0%.

66. A mass spectrometer comprising:

an ion beam attenuator for transmitting and attenuating a beam of ions; and

switching means for switching between a first attenuation mode of operation wherein an ion beam is attenuated by a first factor and a second attenuation mode of operation wherein said ion beam is attenuated by a second different factor;

wherein in said first attenuation mode of operation said ion beam attenuator is repeatedly switched between a first mode of operation wherein the ion transmission is substantially 0% and a second mode of operation wherein the ion transmission is > 0% with a first mark space ratio; and

wherein in said second attenuation mode of operation said ion beam attenuator is repeatedly switched between a first mode of operation wherein the ion transmission is substantially 0% and a second mode of operation wherein the ion transmission is > 0% with a second different mark space ratio.

67. A mass spectrometer as claimed in claim 66, wherein in said first attenuation mode of operation said ion beam attenuator has an average or overall transmission of x1%, wherein x1 is selected from the group consisting of: (i) < 0.01; (ii) 0.01-0.05; (iii) 0.05-0.1; (v) 0.1-0.5; (vi) 0.5-1.0; (vii) 1-5; (viii) 5-10; (ix) 10-15; (x) 15-20; (xi) 20-25; (xii) 25-30; (xiii) 30-35; (xiv) 35-40; (xv) 40-45; (xvi) 45-50; (xvii) 50-55; (xviii) 55-60; (xix) 60-65; (xx) 65-70; (xxi) 70-75; (xxii) 75-80; (xxiii) 80-85; (xxiv) 85-90; (xxv) 90-95; and (xxvi) > 95.

68. A mass spectrometer as claimed in claim 66 or 67, wherein in said second attenuation mode of operation said ion beam attenuator has an average or overall transmission of

x2%, wherein x2 is selected from the group consisting of: (i) < 0.01; (ii) 0.01-0.05; (iii) 0.05-0.1; (v) 0.1-0.5; (vi) 0.5-1.0; (vii) 1-5; (viii) 5-10; (ix) 10-15; (x) 15-20; (xi) 20-25; (xii) 25-30; (xiii) 30-35; (xiv) 35-40; (xv) 40-45; (xvi) 45-50; (xvii) 50-55; (xviii) 55-60; (xix) 60-65; (xx) 65-70; (xxi) 70-75; (xxii) 75-80; (xxiii) 80-85; (xxiv) 85-90; (xxv) 90-95; and (xxvi) > 95.

69. A method of mass spectrometry comprising:

providing an ion beam attenuator for transmitting and attenuating a beam of ions; and

switching between an attenuation mode of operation wherein an ion beam is attenuated and a non-attenuation mode of operation wherein an ion beam is substantially unattenuated, wherein in said attenuation mode of operation said ion beam attenuator is repeatedly switched between a first mode of operation wherein the ion transmission is substantially 0% and a second mode of operation wherein the ion transmission is > 0%.

70. A method of mass spectrometry comprising:

providing an ion beam attenuator for transmitting and attenuating a beam of ions; and

switching between a first attenuation mode of operation wherein an ion beam is attenuated by a first factor and a second attenuation mode of operation wherein said ion beam is attenuated by a second different factor;

wherein in said first attenuation mode of operation said ion beam attenuator is repeatedly switched between a first mode of operation wherein the ion transmission is substantially 0% and a second mode of operation wherein the ion transmission is > 0% with a first mark space ratio; and

wherein in said second attenuation mode of operation said ion beam attenuator is repeatedly switched between a first mode of operation wherein the ion transmission is substantially 0% and a second mode of operation wherein the ion transmission is > 0% with a second different mark space ratio.

71. A method of mass spectrometry as claimed in claim 70, wherein in said first attenuation mode of operation said ion beam attenuator has an average or overall transmission of x1%, wherein x1 is selected from the group consisting of: (i) < 0.01; (ii) 0.01-0.05; (iii) 0.05-0.1; (v) 0.1-0.5; (vi) 0.5-1.0; (vii) 1-5; (viii) 5-10; (ix) 10-15; (x) 15-20; (xi) 20-25; (xii) 25-30; (xiii) 30-35; (xiv) 35-40; (xv) 40-45; (xvi) 45-50; (xvii) 50-55; (xviii) 55-60; (xix) 60-65; (xx) 65-70; (xxi) 70-75; (xxii) 75-80; (xxiii) 80-85; (xxiv) 85-90; (xxv) 90-95; and (xxvi) > 95.

72. A method of mass spectrometry as claimed in claim 70 or 71, wherein in said second attenuation mode of operation said ion beam attenuator has an average or overall transmission of x2%, wherein x2 is selected from the group consisting of: (i) < 0.01; (ii) 0.01-0.05; (iii) 0.05-0.1; (v) 0.1-0.5; (vi) 0.5-1.0; (vii) 1-5; (viii) 5-10; (ix) 10-15; (x) 15-20; (xi) 20-25; (xii) 25-30; (xiii) 30-35; (xiv) 35-40; (xv) 40-45; (xvi) 45-50; (xvii) 50-55; (xviii) 55-60; (xix) 60-65; (xx) 65-70; (xxi) 70-75; (xxii) 75-80; (xxiii) 80-85; (xxiv) 85-90; (xxv) 90-95; and (xxvi) > 95.

73. A mass spectrometer comprising:

an ion beam attenuator for transmitting and attenuating a beam of ions;

switching means for switching between an non-attenuation mode of operation wherein an ion beam is unattenuated and an attenuation mode of operation wherein an ion beam is substantially attenuated, wherein in said attenuation mode of operation said ion beam attenuator is repeatedly switched between a first mode of operation wherein the ion transmission is substantially 0% and a second mode of operation wherein the ion transmission is > 0%;

a mass analyser downstream of said ion beam attenuator; and

a control system;

wherein said mass analyser obtains, in use, first mass spectral data during said non-attenuation mode of operation and second mass spectral data during said attenuation mode of operation; and

wherein said control system further:

(a) interrogates said first mass spectral data;

(b) determines whether at least some of said first mass spectral data may have been affected by saturation, distortion or missed counts; and

(c) uses at least some of said second mass spectral data instead of at least some of said first mass spectral data if it is determined that at least some of said first mass spectral data has been affected by saturation, distortion or missed counts.

74. A mass spectrometer as claimed in claim 73, wherein said ion beam attenuator is regularly and/or repeatedly switched between said non-attenuation mode of operation and said attenuation mode of operation.

75. A mass spectrometer as claimed in claim 73 or 74, wherein said ion beam attenuator is switched between said non-attenuation mode of operation and said attenuation mode of operation with a frequency of < 1 Hz, 1-10 Hz, 10-20 Hz, 20-30 Hz, 30—40 Hz, 40-50 Hz, 50-60 Hz, 60-70 Hz, 70-80 Hz, 80-90 Hz, 90—100 Hz, 100-200 Hz, 200-300 Hz, 300-400 Hz, 400-500 Hz, 500-600 Hz, 600-700 Hz, 700-800 Hz, 800-900 Hz, 900-1000 Hz, 1-10 kHz, 10-20 kHz, 20-30 kHz, 30-40 kHz, 40-50 kHz, 50-60 kHz, 60-70 kHz, 70-80 kHz, 80-90 kHz, 90-100 kHz, 100-200 kHz, 200-300 kHz, 300-400 kHz, 400-500 kHz, 500-600 kHz, 600-700 kHz, 700-800 kHz, 800-900 kHz, 900-1000 kHz or > 1 MHz.

76. A mass spectrometer comprising:

an ion beam attenuator for transmitting and attenuating a beam of ions;

switching means for switching between a first attenuation mode of operation wherein an ion beam is

attenuated by a first factor and a second attenuation mode of operation wherein said ion beam is attenuated by a second different factor;

wherein in said first attenuation mode of operation said ion beam attenuator is repeatedly switched between a first mode of operation wherein the ion transmission is substantially 0% and a second mode of operation wherein the ion transmission is > 0% with a first mark space ratio; and

wherein in said second attenuation mode of operation said ion beam attenuator is repeatedly switched between a first mode of operation wherein the ion transmission is substantially 0% and a second mode of operation wherein the ion transmission is > 0% with a second different mark space ratio;

said mass spectrometer further comprising a mass analyser downstream of said ion beam attenuator; and

a control system;

wherein said mass analyser obtains, in use, first mass spectral data during said first attenuation mode of operation and second mass spectral data during said second attenuation mode of operation; and

wherein said control system further:

(a) interrogates said first mass spectral data;

(b) determines whether at least some of said first mass spectral data may have been affected by saturation, distortion or missed counts; and

(c) uses at least some of said second mass spectral data instead of at least some of said first mass spectral data if it is determined that at least some of said first mass spectral data has been affected by saturation, distortion or missed counts.

77. A mass spectrometer as claimed in claim 76, wherein said ion beam attenuator is regularly and/or repeatedly switched between said first attenuation mode of operation and said second attenuation mode of operation.

78. A mass spectrometer as claimed in claim 76 or 77, wherein said ion beam attenuator is switched between said first attenuation mode of operation and said second attenuation mode of operation with a frequency of < 1 Hz, 1-10 Hz, 10-20 Hz, 20-30 Hz, 30-40 Hz, 40-50 Hz, 50-60 Hz, 60-70 Hz, 70-80 Hz, 80-90 Hz, 90-100 Hz, 100-200 Hz, 200-300 Hz, 300-400 Hz, 400-500 Hz, 500-600 Hz, 600-700 Hz, 700-800 Hz, 800-900 Hz, 900-1000 Hz, 1-10 kHz, 10-20 kHz, 20-30 kHz, 30-40 kHz, 40-50 kHz, 50-60 kHz, 60-70 kHz, 70-80 kHz, 80-90 kHz, 90-100 kHz, 100-200 kHz, 200-300 kHz, 300-400 kHz, 400-500 kHz, 500-600 kHz, 600-700 kHz, 700-800 kHz, 800-900 kHz, 900-1000 kHz or > 1 MHz.

79. A mass spectrometer as claimed in claim 76, 77 or 78, wherein in said first attenuation mode of operation said ion beam attenuator has an average or overall transmission of x1%, wherein x1 is selected from the group consisting of: (i) < 0.01; (ii) 0.01-0.05; (iii) 0.05-0.1; (v) 0.1-0.5; (vi) 0.5-1.0; (vii) 1-5; (viii) 5-10; (ix) 10-15; (x) 15-20; (xi) 20-25; (xii) 25-30; (xiii) 30-35; (xiv) 35-40; (xv) 40-45; (xvi) 45-50; (xvii) 50-55; (xviii) 55-60; (xix) 60-65; (xx) 65-70; (xxi) 70-75; (xxii) 75-80; (xxiii) 80-85; (xxiv) 85-90; (xxv) 90-95; and (xxvi) > 95.

80. A mass spectrometer as claimed in any of claims 76-79, wherein in said second attenuation mode of operation said ion beam attenuator has an average or overall transmission of x2%, wherein x2 is selected from the group consisting of: (i) < 0.01; (ii) 0.01-0.05; (iii) 0.05-0.1; (v) 0.1-0.5; (vi) 0.5-1.0; (vii) 1-5; (viii) 5-10; (ix) 10-15; (x) 15-20; (xi) 20-25; (xii) 25-30; (xiii) 30-35; (xiv) 35-40; (xv) 40-45; (xvi) 45-50; (xvii) 50-55; (xviii) 55-60; (xix) 60-65; (xx) 65-70; (xxi) 70-75; (xxii) 75-80; (xxiii) 80-85; (xxiv) 85-90; (xxv) 90-95; and (xxvi) > 95.

81. A mass spectrometer as claimed in any of claims 73-80, further comprising:

an orthogonal acceleration Time of Flight mass analyser comprising an electrode for orthogonally accelerating ions into a drift region, said electrode being repeatedly energised; and

wherein said control system determines if an individual mass peak in said first mass spectral data exceeds a first predetermined average number of ions per mass to charge ratio value per energisation of said electrode.

82. A mass spectrometer as claimed in claim 81, wherein said first predetermined average number of ions per mass to charge ratio value per energisation of said electrode is selected from the group consisting of: (i) 1; (ii) 0.01-0.1; (iii) 0.1-0.5; (iv) 0.5-1; (v) 1-1.5; (vi) 1.5-2; (vii) 2-5; and (viii) 5-10.

83. A mass spectrometer as claimed in any of claims 73-81, further comprising an orthogonal acceleration Time of Flight mass analyser comprising an electrode for orthogonally accelerating ions into a drift region, said electrode being repeatedly energised; and

wherein said control system determines if an individual mass peak in said second mass spectral data exceeds a second predetermined average number of ions per mass to charge ratio value per energisation of said electrode.

84. A mass spectrometer as claimed in claim 83, wherein said second predetermined average number of ions per mass to charge ratio value per energisation of said electrode is selected from the group consisting of: (i) 1/x; (ii) 0.01/x to 0.1/x; (iii) 0.1/x to 0.5/x; (iv) 0.5/x to 1/x; (v) 1/x to 1.5/x; (vi) 1.5/x to 2/x; (vii) 2/x to 5/x; and (viii) 5/x to 10/x, wherein x is the ratio of the difference in sensitivities between said non-attenuation and attenuation modes or said first and second attenuation modes.

85. A mass spectrometer as claimed in any of claims 73-84, wherein said control system compares the ratio of the

intensity of mass spectral peaks observed in said first mass spectral data with the intensity of corresponding mass spectral peaks observed in said second mass spectral data and determines whether said ratio falls outside a predetermined range.

86. A mass spectrometer as claimed in any of claims 73-85, wherein said control system determines whether at least some of said first mass spectral data may have been affected by saturation, distortion or missed counts and monitors the total ion current and determines whether the total ion current exceeds a predetermined level.

87. A mass spectrometer as claimed in any of claims 73-86, wherein if said control system determines that substantially all of said first mass spectral data may have been affected by saturation, distortion or missed counts said control system uses said second mass spectral data instead of said first mass spectral data.

88. A mass spectrometer as claimed in claim 87, wherein said control system determines whether the total ion current recorded in said non-attenuation or first attenuation mode exceeds a predetermined limit.

89. A mass spectrometer as claimed in claim 87 or 88, wherein said control system determines whether the output current of an electron multiplication device exceeds a predetermined limit.

90. A mass spectrometer as claimed in claim 87, 88 or 89, wherein said control system monitors a single mass spectral peak or summation of mass spectral peaks and determines the intensity of said single mass spectral peak or summation of mass spectral peaks.

91. A mass spectrometer as claimed in any of claims 87-90, wherein said control system monitors an ion current with a

further detection device provided upstream of an ion detector.

92. A method of mass spectrometry comprising:

providing an ion beam attenuator for transmitting and attenuating a beam of ions; and

switching between an non-attenuation mode of operation wherein an ion beam is unattenuated and an attenuation mode of operation wherein an ion beam is substantially attenuated, wherein in said attenuation mode of operation said ion beam attenuator is repeatedly switched between a first mode of operation wherein the ion transmission is substantially 0% and a second mode of operation wherein the ion transmission is > 0%;

providing a mass analyser downstream of said ion beam attenuator; and

wherein said mass analyser obtains, in use, first mass spectral data during said non-attenuation mode of operation and second mass spectral data during said attenuation mode of operation;

said method further comprising:

interrogating said first mass spectral data;

determining whether at least some of said first mass spectral data may have been affected by saturation, distortion or missed counts; and

using at least some of said second mass spectral data instead of at least some of said first mass spectral data if it is determined that at least some of said first mass spectral data has been affected by saturation, distortion or missed counts.

93. A method of mass spectrometry as claimed in claim 92, further comprising regularly and/or repeatedly switching said ion beam attenuator between said non-attenuation mode of operation and said attenuation mode of operation.

94. A method of mass spectrometry as claimed in claim 92 or 93, further comprising switching said ion beam attenuator

between said non-attenuation mode of operation and said attenuation mode of operation with a frequency of < 1 Hz, 1-10 Hz, 10-20 Hz, 20-30 Hz, 30-40 Hz, 40-50 Hz, 50-60 Hz, 60-70 Hz, 70-80 Hz, 80-90 Hz, 90-100 Hz, 100-200 Hz, 200-300 Hz, 300-400 Hz, 400-500 Hz, 500-600 Hz, 600-700 Hz, 700-800 Hz, 800-900 Hz, 900-1000 Hz, 1-10 kHz, 10-20 kHz, 20-30 kHz, 30-40 kHz, 40—50 kHz, 50-60 kHz, 60-70 kHz, 70-80 kHz, 80-90 kHz, 90-100 kHz, 100-200 kHz, 200-300 kHz, 300-400 kHz, 400-500 kHz, 500-600 kHz, 600-700 kHz, 700-800 kHz, 800-900 kHz, 900-1000 kHz or > 1 MHz.

95. A method of mass spectrometer comprising:

providing an ion beam attenuator for transmitting and attenuating a beam of ions;

switching between a first attenuation mode of operation wherein an ion beam is attenuated by a first factor and a second attenuation mode of operation wherein said ion beam is attenuated by a second different factor;

wherein in said first attenuation mode of operation said ion beam attenuator is repeatedly switched between a first mode of operation wherein the ion transmission is substantially 0% and a second mode of operation wherein the ion transmission is > 0% with a first mark space ratio; and

wherein in said second attenuation mode of operation said ion beam attenuator is repeatedly switched between a first mode of operation wherein the ion transmission is substantially 0% and a second mode of operation wherein the ion transmission is > 0% with a second different mark space ratio;

providing a mass analyser downstream of said ion beam attenuator wherein said mass analyser obtains first mass spectral data during said first attenuation mode of operation and second mass spectral data during said second attenuation mode of operation; and

said method further comprising:

interrogating said first mass spectral data;

determining whether at least some of said first mass spectral data may have been affected by saturation, distortion or missed counts; and

using at least some of said second mass spectral data instead of at least some of said first mass spectral data if it is determined that at least some of said first mass spectral data has been affected by saturation, distortion or missed counts.

96. A method of mass spectrometry as claimed in claim 95, further comprising regularly and/or repeatedly switching said ion beam attenuator between said first attenuation mode of operation and said second attenuation mode of operation.

97. A method of mass spectrometry as claimed in claim 95 or 96, further comprising switching said ion beam attenuator between said first attenuation mode of operation and said second attenuation mode of operation with a frequency of < 1 Hz, 1-10 Hz, 10-20 Hz, 20—30 Hz, 30-40 Hz, 40-50 Hz, 50-60 Hz, 60-70 Hz, 70-80 Hz, 80-90 Hz, 90-100 Hz, 100-200 Hz, 200-300 Hz, 300-400 Hz, 400-500 Hz, 500-600 Hz, 600-700 Hz, 700—800 Hz, 800-900 Hz, 900-1000 Hz, 1-10 kHz, 10-20 kHz, 20-30 kHz, 30-40 kHz, 40-50 kHz, 50-60 kHz, 60-70 kHz, 70-80 kHz, 80-90 kHz, 90-100 kHz, 100-200 kHz, 200-300 kHz, 300-400 kHz, 400-500 kHz, 500-600 kHz, 600-700 kHz, 700-800 kHz, 800-900 kHz, 900-1000 kHz or > 1 MHz.

98. A method of mass spectrometry as claimed in claim 95, 96 or 97, wherein in said first attenuation mode of operation said ion beam attenuator has an average or overall transmission of x1%, wherein x1 is selected from the group consisting of: (i) < 0.01; (ii) 0.01-0.05; (iii) 0.05-0.1; (v) 0.1-0.5; (vi) 0.5-1.0; (vii) 1-5; (viii) 5-10; (ix) 10-15; (x) 15-20; (xi) 20-25; (xii) 25-30; (xiii) 30-35; (xiv) 35-40; (xv) 40-45; (xvi) 45-50; (xvii) 50-55; (xviii) 55-60; (xix) 60-65; (xx) 65-70; (xxi) 70-75; (xxii) 75-80; (xxiii) 80-85; (xxiv) 85-90; (xxv) 90-95; and (xxvi) > 95.

99. A method of mass spectrometry as claimed in any of claims 95-98, wherein in said second attenuation mode of operation said ion beam attenuator has an average or overall transmission of x2%, wherein x2 is selected from the group consisting of: (i) < 0.01; (ii) 0.01-0.05; (iii) 0.05-0.1; (v) 0.1-0.5; (vi) 0.5-1.0; (vii) 1-5; (viii) 5-10; (ix) 10-15; (x) 15-20; (xi) 20-25; (xii) 25-30; (xiii) 30-35; (xiv) 35-40; (xv) 40-45; (xvi) 45-50; (xvii) 50-55; (xviii) 55-60; (xix) 60-65; (xx) 65-70; (xxi) 70-75; (xxii) 75-80; (xxiii) 80-85; (xxiv) 85-90; (xxv) 90-95; and (xxvi) > 95.

100. A method of mass spectrometry as claimed in any of claims 92-99, wherein said step of determining whether at least some of said first mass spectral data may have been affected by saturation, distortion or missed counts comprises:

providing an orthogonal acceleration Time of Flight mass analyser comprising an electrode for orthogonally accelerating ions into a drift region, said electrode being repeatedly energised; and

determining if an individual mass peak in said first mass spectral data exceeds a first predetermined average number of ions per mass to charge ratio value per energisation of said electrode.

101. A method of mass spectrometry as claimed in claim 100, wherein said first predetermined average number of ions per mass to charge ratio value per energisation of said electrode is selected from the group consisting of: (i) 1; (ii) 0.01-0.1; (iii) 0.1-0.5; (iv) 0.5-1; (v) 1-1.5; (vi) 1.5-2; (vii) 2-5; and (viii) 5—10.

102. A method of mass spectrometry as claimed in any of claims 92-101, wherein said step of determining whether at least some of said first mass spectral data may have been affected by saturation, distortion or missed counts comprises:

providing an orthogonal acceleration Time of Flight mass analyser comprising an electrode for orthogonally accelerating ions into a drift region, said electrode being repeatedly energised; and

determining if an individual mass peak in said second mass spectral data exceeds a second predetermined average number of ions per mass to charge ratio value per energisation of said electrode.

103. A method of mass spectrometry as claimed in claim 102, wherein said second predetermined average number of ions per mass to charge ratio value per energisation of said electrode is selected from the group consisting of: (i) 1/x; (ii) 0.01/x to 0.1/x; (iii) 0.1/x to 0.5/x; (iv) 0.5/x to 1/x; (v) 1/x to 1.5/x; (vi) 1.5/x to 2/x; (vii) 2/x to 5/x; and (viii) 5/x to 10/x, wherein x is the ratio of the difference in sensitivities between said non-attenuation and attenuation modes or said first and second attenuation modes.

104. A method of mass spectrometry as claimed in any of claims 92-103, wherein said step of determining whether at least some of said first mass spectral data may have been affected by saturation, distortion or missed counts comprises:

comparing the ratio of the intensity of mass spectral peaks observed in said first mass spectral data with the intensity of corresponding mass spectral peaks observed in said second mass spectral data; and

determining whether said ratio falls outside a predetermined range.

105. A method of mass spectrometry as claimed in any of claims 92-104, wherein said step of determining whether at least some of said first mass spectral data may have been affected by saturation, distortion or missed counts comprises:

monitoring the total ion current; and

determining whether the total ion current exceeds a predetermined level.

106. A method of mass spectrometry as claimed in any of claims 92-105, further comprising:

determining that substantially all of said first mass spectral data may have been affected by saturation, distortion or missed counts; and

using said second mass spectral data instead of said first mass spectral data.

107. A method of mass spectrometry as claimed in claim 106, wherein the step of determining that substantially all of said first mass spectral data may have been affected by saturation, distortion or missed counts comprises:

determining whether the total ion current recorded in said non-attenuation or first attenuation mode exceeds a predetermined limit.

108. A method of mass spectrometry as claimed in claim 106 or 107, wherein the step of determining that substantially all of said first mass spectral data may have been affected by saturation, distortion or missed counts comprises:

determining whether the output current of an electron multiplication device exceeds a predetermined limit.

109. A method of mass spectrometry as claimed in claim 106, 107 or 108, wherein the step of determining that substantially all of said first mass spectral data may have been affected by saturation, distortion or missed counts comprises:

monitoring a single mass spectral peak or summation of mass spectral peaks; and

determining the intensity of said single mass spectral peak or summation of mass spectral peaks.

110. A method of mass spectrometry as claimed in any of claims 106-109, wherein the step of determining that

substantially all of said first mass spectral data may have been affected by saturation, distortion or missed counts comprises:

monitoring the ion current with a further detection device provided upstream of an ion detector.